OPPORTUNITIES FOR SOLAR WATER HEATING

FINAL REPORT

Prepared for

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, CO 80401-3393

Prepared by

NAHB Research Center, Inc.
400 Prince George's Boulevard
Upper Marlboro, MD 20774-8731

January 1998

NAHB RESEARCH CENTER

ACKNOWLEDGMENTS

This report was prepared by the NAHB Research Center, Inc. under contract to the client. The principal authors of this report were Christine Thompson Barbour, Brian Dyson, Christopher J. Fennell, and Karen Johnson. Contributions to the finished work were made by Karin Victorio.

ABOUT THE NAHB RESEARCH CENTER

The NAHB Research Center is a not-for-profit subsidiary of the National Association of Home Builders (NAHB). The NAHB has 190,000 members, including 50,000 builders who build more than 80 percent of American homes. The Research Center conducts research, analysis, and demonstration programs in all areas relating to home building; carries out extensive programs of information dissemination and interchange among members of the industry, and between the industry and the public.

NAHB Research Center, Inc.
400 Prince George's Boulevard
Upper Marlboro, MD 20774-8731
☎ (301) 249-4000 or (800) 638-8556
Fax (301) 249-0305
www.nahbrc.org

OPPORTUNITIES FOR SOLAR WATER HEATING

FINAL REPORT

Prepared for

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, CO 80401-3393

Prepared by

NAHB Research Center, Inc.
400 Prince George's Boulevard
Upper Marlboro, MD 20774-8731

January 1998

TABLE OF CONTENTS

EXECUTIVE SUMMARY

To understand regional differences in construction practices and familiarity with solar water heating, a series of eight focus groups was held with homogeneous groups of builders, contractors, and architects in three regions across the United States.

A. CHARACTERISTICS OF THE GROUPS

- Participants represented a diverse group of builders, architects, and trade contractors who had varied experiences with solar water heating. Builder group size ranged from three to eleven respondents, the architect group consisted of 12 respondents, and the contractor groups consisted of eight and nine respondents.

B. WATER HEATING BUSINESS AND THE DECISION-MAKING PROCESS

- Builders stated that decisions related to water heating are primarily made based on low first cost and consumer preference. Most builders said they typically specified the type, size, efficiency and price range of water heaters and plumbers purchased and installed the equipment within the parameters established by the builder on a firm, fixed-price basis. Some builders were not very familiar with the cost of the water heater because it was purchased as part of the plumber's total bid along with piping, fixtures, and faucets. Gas units were perceived as having a higher installed cost.

- Most respondents offered natural gas water heaters if they were available because they were thought to be less expensive to operate, have quicker heat recovery, and were preferred by most customers.

- Builders considered home buyers the key decision makers in the choice of water heating options. Architects considered themselves the key decision makers, and contractors thought the general contractor was the key decision maker in the choice of a water heater.

- Custom/luxury builders offered several options to reduce hot water delivery time including recirculating pumps, heat recovery systems, multiple water heaters and solar water heating. Starter home builders in Sacramento often did not consider other options because water heaters were so reliable.

- The requirements of Title 24 and the California Energy Code led starter and move-up builders in Sacramento to suggest that the construction trade-offs needed to compensate for the inefficiency of electric water heaters made them prohibitively expensive.

- Respondents were asked to list the most and least important criteria for choosing a water heating system. Cost, efficiency, and recovery time were the most frequently cited attributes that were important to builders. Architects and contractors were concerned with availability, code acceptance, home owner preference, recovery time, warranty, worker

familiarity with installation, and the impact on the builder. Several key criteria for choosing a water heater identified by builders across market segments were directly related to meeting customer expectations. No builder identified water heater appearance as important.

C. Perceptions of Solar Water Heating

- In all groups, respondents had some familiarity with solar water heating. In some cases, builders had direct experience with solar water heating on their own homes as well as on homes they built.

- Many builders had negative top-of-mind reactions to the term "solar water heating." Overall, they were skeptical about the cost-effectiveness of solar water heaters. They also feared bad installations that would cause roof leaks and they perceived the solar collectors to be ugly. Architects had both positive and negative reactions to solar water heating. They viewed active solar water heating as positive in areas that were not subject to freezing, but had negative comments about passive solar water heating. Contractors had some positive and negative responses to both active and passive heating.

- Builders and architects pointed out that a community that is not in favor of solar can make doing business very difficult for builders who utilize solar water heating on their homes.

- Some groups were asked to give their reactions when shown photographs of different solar water heating systems. Photos shown included a solar/photovoltaic system, two rectangular metal and glass panels mounted to the roof several feet apart, and a single glass and metal panel attached to a roof. Builder expectations that solar water heating systems would be unattractive were confirmed by Photos 1 and 2, but they thought the system shown in the third photograph was attractive. Contractors had negative comments about the system shown in the first photo, but thought the second and third photos were attractive.

- Concerns were raised about the impact a solar water heater would have on the construction process and additional labor costs from several trade contractors.

D. Technical and Economic Performance Criteria

- In the discussion of technical criteria, builders did not discuss efficiency, capacity, or recovery time; they were more interested in the basic performance issue that solar water heating will work and not cause them additional difficulties over time. Architects discussed making solar water heaters as reliable and unobtrusive as conventional water heaters. Contractors discussed the installation extensively, and believed that the installation needed to be simplified and standardized.

- There was generally a limited understanding by builders about the costs for currently

available solar water heating systems. They perceived that they were significantly more expensive than they actually are. Several move-up builders felt that home owners liked to talk about being environmentally conscientious but were not willing to pay more for it.

- Architects were more concerned with economic criteria than technical criteria. They believed that a solar water heating system should cost the same as a conventional system and that rebates and incentives should be available to both home buyers and home builders.

- Trade contractors believed that in order for solar water heaters to be competitive, they would have to be cost effective and have a relatively short payback time.

E. Builder Perceptions of Home Buyers, Builders, and Contractors

- Builders felt that consumers did not want to think about their water heating system or maintenance, and that, despite being concerned about the environment, they home owners more concerned about price, aesthetics, and resale.

- Architects believed that consumers were concerned with aesthetics, maintenance, and monthly cost. Contractors suggested that solar water heating would have to offer a sense of value before home owners would accept it.

- The builders did not agree on who should install solar water heaters. Both move-up and custom builders in Orlando thought that specialty contractors should install the system. Starter builders in Sacramento felt that existing contractors should install SWHs instead of a new contractor that might go out of business. Move-up builders in Phoenix believed that a large plumbing firm with an established reputation would be the ideal contractor to install a SWH system.

- Move-up builders in Phoenix discussed the effect of SWHs on the construction process. Many felt that installing a SWH would affect the construction of the roof and cause leaks, and that contractors would prefer the unit on the ground, where it would cause fewer problems. They felt the impact of SWH installation on carpenters and plumbers would be limited.

F. Advice to the Solar Industry

- The groups made several suggestions for the solar industry, including improving marketing, aesthetics, installation, image, and design; making it affordable; educating consumers; providing technical assistance and a good warranty; and having incentives/rebates, product support, knowledgeable contractors, good performance data, payback, and reliability.

- The groups also made several suggestions for forming partnerships with the government, utilities, manufacturers, suppliers, distributors, and/or builders.

G. Conclusions

Based on the qualitative market research conducted for NREL the following key conclusions can be drawn:

- Appearance was not a consideration for traditional water heaters but, was the largest concern for SWH panels since they are visible when mounted on roofs. Most builders and architects related their perceptions to roof mounted panels. Their reactions to building-integrated SWH systems were more positive.

- One of the largest barriers to the adoption of SWH is builder and buyer satisfaction with existing gas water heaters; they provide the desired recovery time and are perceived as reliable.

- Past state and Federal incentive programs, where a number of contractors entered the market just to save money, created negative perceptions of SWH which must be overcome. Architects noted eliminating the term 'solar' would change negative associations with the historic product.

- Builders considered themselves the primary decision makers for water heating systems. They will react to market demand and will build what their customers want; they do not perceive the market demand now. Architects were influential in the high-end custom market; they were relatively knowledgeable and open to SWH. Plumbers wanted to be the trade responsible for SWH installations since they have many of the necessary skills.

H. Recommended Technology Development, Market Development, and Other Courses of Action

- Conduct applications engineering, field testing, and market demonstrations with opinion leading builders and their trade contractors to integrate SWHs into new residential construction.

- Conduct market research on effective messages and channels for creating builder and consumer demand.

- Address solar collector design issues through charrettes with architects.

I. INTRODUCTION

PURPOSE

The National Renewable Energy Laboratory (NREL) and the Solar Energy Industry Association (SEIA) commissioned the NAHB Research Center, Inc., a not-for-profit subsidiary of the National Association of Home Builders, to conduct qualitative research in the form of focus groups to assess the perceptions, opinions, beliefs, and attitudes of key residential construction decision-makers on solar water heaters (SWHs). The research results are intended to support the NREL/SEIA management team with the formulation of technology and market development programs.

Specific topics of investigation included: water heating decision making, perceptions of solar water heating, solar water heating technical and economic performance criteria, and advice to the solar industry.

METHODOLOGY

To understand regional differences in construction practices and familiarity with solar water heating, a series of eight focus groups was held with homogeneous groups of builders, contractors, and architects in three regions across the United States as follows:

Table 1: Focus Groups

REGION I ORLANDO, FL		REGION II PHOENIX, AZ		REGION III SACRAMENTO, CA	
• Move-up builders	July 25, 1997	• Move-up builders	August 21, 1997	• Move-up builders	October 1, 1997
• Custom builders	July 26, 1997	• Architects	August 21, 1997	• Starter builders	September 30, 1997
				• Trade Contractors (No solar experience)	September 30, 1997
				• Trade Contractors (With solar experience)	October 1, 1997

Standard two-hour focus groups were conducted by Christine Thompson Barbour and Christopher J. Fennell, professionally trained moderators with the NAHB Research Center, Inc. The focus groups were video and audio taped, and clients viewed the process from behind a one-way mirror. Respondent verbatims are italicized with quotations. Participants in the focus groups were recruited according to the following criteria:

Builders

- Constructs new single-family homes;
- Custom builders construct fewer than 25 homes per year;
- Production builders construct more than 100 homes per year;
- Builds starter homes priced at less than $108,000 in Sacramento; or
- Builds move-up homes priced from
    - $108,000 to $300,000 in Sacramento,
    - from $130,000 to $205,000 in Florida,
    - from $120,000 to $400,000 in Phoenix; or
- Builds custom/luxury homes priced at more than $205,000 in Florida; and
- Has experience making decisions regarding specification of water heaters.

Architects

- Works for a firm that designs single-family homes;
- Designs custom/luxury homes;
- Designs homes with a typical selling price of more than $300,000; and
- Has experience specifying water heaters.

Trade Contractors

- Works for a firm that provides plumbing, roofing, or solar water heating services; and
- At least 25 percent of business is new residential construction; and
- Has prior experience with solar water heating; or
- Has no prior experience with solar water heating; and
- Has experience making decisions regarding specification/installation of domestic water heaters, roofing materials, or solar water heating systems.

STATEMENT OF LIMITATIONS

Focus groups seek to develop insight into attitudes, beliefs, and opinions rather than precise quantitative measures. Because of the limited number of respondents and the restrictions imposed on recruiting, this research must be considered in a qualitative frame of reference. The data presented here cannot be projected to a universe of similar respondents.

The value of focus groups is in their ability to provide observers with unfiltered, unbiased comments from a segment of the target population and for decision-makers to gain insight on the perceptions of their consumer base.

II. NON-EXPERIENCED BUILDERS ACROSS REGIONS

A. CHARACTERISTICS OF THE GROUPS

Participants represented a diverse group of builders. In addition to building homes in the defined market segment for their focus group, each builder noted that they also built homes in other market segments and price ranges. Many of the respondents had diversified businesses and constructed a range of building types including move-down homes for retirees, residential and commercial remodeling, condominiums, and land development. The number of homes built by the firms represented in each session ranged from two homes to more than 1,600 homes per year.

Table 2: Builder Characteristics

ORLANDO, FL		PHOENIX, AZ	SACRAMENTO, CA	
Move-up Builders	**Custom/Luxury Builders**	**Move-up builders**	**Move-up builders**	**Starter/Entry-level Builders**
• Eight participants • From 3 to 100 homes per year • From across Florida • Also move-downs, remodeling, commercial, land development • $130,000 to $205,000 price range	• Eleven participants • From 3 to 500 homes per year • From across Florida • Three proprietors • Condominiums, commercial remodeling • $80,000 to $5,000,000 price range	• Ten participants • From 2 to 1,600 homes per year • Three national builders • Five proprietors • Purchasing and production mgrs. • Master-planned to scattered lots • $200,000 price point	• Six participants • From 5 to 350 homes per year • $250,000 price point	• Three participants • From 10 to 70 homes per year • Some with solar experience • $95,000 to $150,000 price range

B. WATER HEATING BUSINESS AND DECISION MAKING

Decision-Making Process

Builders said that they base decisions related to water heating primarily on low first cost and consumer preference. Often, consumers do not give their water heating systems much thought as part of the new home purchase process. They want something that meets their needs by providing instantaneous hot water. Customer satisfaction was very important to the builders.

Most builders said they typically specified the type, size, efficiency and price range of water heaters and plumbers purchased and installed the equipment within the parameters

established by the builder on a firm fixed-price basis. Manufacturers' brand name was not important to them as long as the equipment used had a *"good name backed by a warranty and an efficiency rating."*

First Cost

Some builders were not very familiar with the cost of the water heater because it was purchased as part of the plumber's total bid along with piping, fixtures, and faucets. Gas units were perceived as having a higher installed cost ($500 to $750) to account for piping, chimneys, and flues. Electric units cost $250 to $350 with no additional construction costs.

> *"[The bid] includes a cost related to the whole gas system to run it through the location and the water heater, as well as the cost of the water heater itself. [A water heater] is not something that you itemize."*

> *"You gotta get the gas there, you gotta stack it out, you gotta buy the [gas] heater. With electric all you do is by the heater."*

Gas Preference

Most respondents offered natural gas water heaters if they were available because they were thought to be less expensive to operate, have quicker heat recovery, and were preferred by most customers. Move-up builders typically specified 40 gallon gas water heaters and 50 gallon electric water heaters. Electric water heaters were specified with larger capacity than gas units to accommodate their slower recovery time.

> *"You get faster recovery with the gas and you can drop down to a little smaller unit."*

Options

Although move-up builders stated that home buyers did not often think about water heating, they considered home buyers the key decision makers in the choice of water heating options. Their customers sometimes requested a larger size water heater or a specific type of water heater based on their past experiences.

Custom/luxury builders offered several options to reduce hot water delivery time including recirculating pumps, heat recovery systems, multiple water heaters, and solar water heating in homes larger than 3,000 square feet at an additional cost of $400 to $1,000. This indicates that custom/luxury home buyers will pay more for water heating upgrades that increase water heating system performance.

Starter home builders in Sacramento often did not consider other options because water heaters were so reliable that they were not concerned with them. They noted that water heaters were cheap and easy to replace.

"This [a water heater] is just super reliable, it's cheap, it's like your watch keeps ticking. One goes out every 10 or 15 years maybe and they're not that expensive to replace. People don't worry about them and we don't worry about them. We have much greater things to worry about than the water heater."

Construction Tradeoffs

The requirements of Title 24 and the California Energy Code led starter and move-up builders in Sacramento to suggest that the construction tradeoffs needed to compensate for the inefficiency of electric water heaters made them prohibitively expensive. Many of these builders had never even installed an electric water heater. They stated that it is sometimes worth the considerable expense to bring in natural gas because gas water heaters made it easier to comply with the local codes. Easy to implement construction tradeoffs, such as wrapping water heaters with insulative blankets, were often done to *"gain a couple of points for Title 24 and to meet the energy code."*

"We actually brought in gas to a site that wasn't set up for it and [it cost] $1800, $1900 [per home] to bring it in. But because it cost so much to get the house in compliance with an electric water heater, my boss [felt it was worth it]."

Construction Process

Water heaters were installed during the trim and finish stage at the same time as plumbing fixtures such as sinks and toilets. Builders noted that some coordination took place among their trade contractors with gas water heaters since the HVAC contractor put the vents in during rough framing in anticipation of the water heater to be installed later.

Criteria for Choosing Water Heating Systems

Respondents were asked to list the most and least important criteria for choosing a water heating system. Cost, efficiency, and recovery time were the most frequently cited attributes that were important to builders.

Most Important Attributes

Table 3: Builder Most Important Water Heater Attributes

Most Important Attributes	ORLANDO, FL		PHOENIX, AZ	SACRAMENTO, CA	
	Move-up Builders	Custom/ Luxury Builders	Move-up Builders	Move-up Builders	Starter/ Entry Level Builders
Availability of equipment	●			●	●
Availability of natural gas		●			
Capacity	●	●		●	
Code official acceptance	●				
Compatibility with equipment	●				
Cost		●	●	●	●
Efficiency	●		●	●	●
Home buyer preference	●				
Impact on builder reputation	●				
Physical Size		●	●		
Reduced Callbacks/ Leaks/ Customer Satisfaction	●	●	●		●
Rebates			●		
Recovery time	●	●	●	●	
Reliability	●	●	●		●
Safety	●		●		
Venting		●	●		
Warranty		●	●	●	

Several key criteria for choosing a water heater identified by builders across market segments were directly related to meeting customer expectations.

Efficiency/Recovery Time. Move-up builders in each location shared the view with starter builders in Sacramento that efficiency was a very important attribute for selecting a water heater. Custom/luxury builders in Florida were in agreement with move-up builders in each session that recovery time was vital to them during the water heater selection process. The importance of reliability and reduced callbacks/customer satisfaction were highlighted by builders in each location.

Cost. Move-up builders in Florida were the only group not to list cost as one of their most important product selection attributes. However, the critical nature of first cost was mentioned by them at several other times during the session.

Availability. The importance of equipment availability to move-up and starter builders was reinforced by the following:

> *"because if you're doing 100 houses in a period of three months, you need to have a company that's going to be able to provide 100 water heaters."*

Warranty. Custom and move-up builders identified warranties as important. They stated that a warranty should cover labor and materials for two to five years with full replacement rather than prorated equipment value.

Buyer Preference. Home buyer preference is the only water heater selection criteria that was identified as being important (by move-up builders in Florida) and not important (by move-up builders in Phoenix). This may be due to move-up builders, who focus extensively on customer satisfaction, finding that water heating systems were not critically important to their customers. Home buyers take it for granted that their water heater will always work as intended.

Least Important Attributes

Table 4: Builder Least Important Water Heater Attributes

Least Important Attributes	ORLANDO, FL		PHOENIX, AZ	SACRAMENTO, CA	
	Move-up Builders	Custom/ Luxury Builders	Move-up Builders	Move-up Builders	Starter/ Entry Level Builders
Appearance	●	●		●	●
Brand name			●		
Environmental image				●	
Home buyer preference			●		
No special worker training	●				
Positive monthly cash flow for home owners		●			
Rebates/financing	●	●			●
Use by other builders	●	●	●	●	

No builder identified water heater appearance as important. Appearance and use by other builders were important to water heater selection. A builder in Sacramento suggested that water heater appearance would only be important if the equipment were installed in a garage. The move-up and custom/luxury builders shared the feeling that water heater use by other builders was not important

Criteria for Switching

Overall, water heaters were not a product home builders were likely to switch readily. Move-up builders in Phoenix indicated that rebates were the only selection criteria that would lead them to switch from one type of water heater to another. They stated that incentives were widely provided by utility companies to get builders to dedicate new communities to gas or electric service early in the development process. Builders were interested in this type of rebate because they received the financial benefit on a per home basis through an agreement directly with their utility company. They suggested that equipment rebates originated with the equipment manufacturer and would more likely be paid to the home owner or the subcontractor who purchased the equipment, providing no financial benefit to the builder.

Florida and Sacramento move-up builders stated they would switch water heating type from gas to electric if natural gas were unavailable or where, "*gas was too expensive to bring in.*". They provided liquid petroleum (LP) gas for customers who did not want electric water heating in areas without natural gas. Conversely, a small number of home buyers consider gas hazardous and prefer electricity.

C. Perceptions of Solar Water Heating

In all groups, respondents had some familiarity with solar water heating. In some cases, builders had direct experience with solar water heating on their own homes as well as on homes they built.

Orlando

Move-up and custom/luxury builders in Orlando provided the following top-of-mind reactions to the term "solar water heating."

- *"Inefficient."*
- *"Low consumer awareness."*
- *"Not reliable."*
- *"Questionable because of liability."*
- *"Roof damage."*
- *"Roof leaks."*
- *"Too expensive, even in million dollar homes."*
- *"Ugly." "They get an 'A' for ugly."*

Overall, they were skeptical about the cost-effectiveness of SWHs. They also feared bad installations that would cause roof leaks and they perceived the solar collectors to be ugly.

They were knowledgeable about the basic concept of solar water heating; they pointed out that it had been used in Florida for decades. Many had negative perceptions based on what they had heard or experienced in the past. Concerns about roof damage and leaks were related to Florida's location in a hurricane zone and widespread use of roofing tiles that were

easily cracked. Reservations about high first cost were compounded by the suggestion that the cost of a SWH would not be reflected in the home's appraisal.

Restrictions

Some builders perceived that solar collectors were not allowed in some communities, but other builders pointed out that neighborhood associations and Community Covenants and Restrictions (CC&R's) cannot by law prohibit solar collectors in Florida or Arizona. Nonetheless, a community that is not in favor of solar can make doing business very difficult for builders who utilize solar water heating on their homes. Some also refused skylights if they could be seen from the road.

Tax Incentives

Frequent references were made to the mistakes made in the 1980s by individuals who wanted to make 'easy' money from Federal tax credits. According to builders, many installers and manufacturers who got into the solar water heating market during the time of the Federal tax incentives lacked experience and expertise, resulting in numerous failed installations and unsatisfied warranty and service claims. The installers and manufacturers who survived after the elimination of the tax incentives were perceived as reliable and reputable.

> *"Solar suffers from the reputation when it first hit the market and everyone came up with some kind of solar system and a lot of them were really poorly engineered and I think that reputation to this day really plagues the solar industry."*

> *"There's not that many people making panels today, but the ones they make seem to be trouble free and the guarantees are very long."*

Solar Experience

Several builders with solar water heating experience noted positive customer satisfaction and no problems with roof leaks. They felt that solar water heating would become more important in the future. A builder in Arizona noted almost 15 years of trouble-free solar water heating in his own home. Conversely, a builder in Florida was unaware that the SWH on his home was inoperative until his primary water heater failed.

Table 5: Builder Reactions to Key Terms

Key Terms	PHOENIX, AZ	SACRAMENTO, CA	
	Move-up Builders	Move-up Builders	Starter/Entry-Level Builders
Active Solar Water Heating	*I don't know; Don't understand the terminology*	*Something not cost effective*	*Expensive and not necessary at this point.*
Electric Water Heater	*Standard; Slow recovery; Most practical on market today*	*Inefficient; Expensive; Don't use it; Cost to the consumer*	*Expensive to run; Dinosaur; Except where you have to use them you don't; Some people are afraid of gas*
Gas Water Heater	*Standard; Recovery; Most practical on market today*	*Practical; Quicker recovery; Smaller storage tank with gas*	*They're standard; They work; They're so efficient*
Million Solar Roofs Initiative	*Somebody's dream; Bill Clinton's goal; Mandated in Southern California; Government program*	*What is it?;* Related to current SMUD program	*I haven't heard of it; Sounds like some sort of a non-profit deal or something; Negative;* Doubts about payback
Passive Solar Water Heating	*Worse; Black rubber hoses on roof; Just for the pool*	*I'm not sure what that is, passive; It's usually not very aesthetically pleasing; Drums of water*	*Inefficient; I've done it; It worked but so what? Maybe it saved a few dollars a month, but it cost a lot of money to put in.*
Photovoltaics	*Photo cells to heat hot water; Generate own electricity; Need back-up system; Cloudy days; No hot water*	*Cost*	*Got pretty excited about them about 15 years ago when it looked like they would allow you to run the whole house off of photovoltaic; They take way more space than solar panels; Not attractive at all;* Concerns about cost
Solar Energy Industry Association	*Somebody selling solar hot water heaters; Hand in the governments' pocket*	*A bureaucracy*	*If they can figure out how to make it work it'd be great, but so far, everything I've heard of that's been tried is extremely expensive.*

Reactions to Terms

Starter/entry level and move-up builders in Phoenix and Sacramento were asked to give top-of-mind responses to key words related to solar water heating. Their responses are presented in Table 5.

Electric/Gas Water Heaters. Electric water heaters were viewed negatively because they were expensive to operate and slow to recover. They were generally only used where gas was not available, where the home owner had safety reservations about gas, or where physical constraints precluded the use of a gas water heater. Gas water heaters were identified by each group as being practical, reliable, and efficient with a quick recovery time.

Active/Passive Solar Water Heating. Most builders were either not familiar with active solar water heating or felt that it would not be cost effective. Passive solar water heating was more readily understood than active solar and was considered to be inefficient and not aesthetically pleasing. Reactions to solar water heating centered on the high maintenance, expensive and inefficient systems of the 1970s.

Photovoltaics. Some respondents clearly understood that photovoltaics (PV) produce electricity, while others believed they produced hot water. Cost and poor aesthetics were key concerns among builders about PV though there was a feeling that PV was a promising technology for the future.

Solar Energy Industries Association. None of the builders expressed familiarity with the Solar Energy Industries Association. They suggested that it was getting government funding to support sales of SWHs but had not been able to create a cost-effective approach to mainstream solar.

Million Solar Roofs Initiative. Awareness of the Million Solar Roofs Initiative was very limited. The move-up builders in Arizona suggested it was a new state or Federal program possibly supported by President Clinton.

Reactions to Photographs. The respondents were shown photographs and diagrams of several currently available solar water heating systems (See Appendix A)

Photo 1. The first photo showed a combined solar/photovoltaic system mounted to a rack standing several feet above the plane of the roof. Comments from the builders were dismissive and almost entirely about aesthetics. Reactions to Photograph 1 included the following:

- *"They are just as ugly as we thought they were."*
- *"You're not gonna put that up in an upgraded neighborhood."*
- *"The Home owners Association won't let you put that up."*
- *"It's cool. They're tryin' to save energy...as a businessman, I say ugly, ugly, ugly."*
- *"I wouldn't do that to my house."*
- *"The reason that looks like that is because they couldn't face it south...they faced it east or west and mangled it up..."*

Photo 2. The second photo showed two rectangular glass and metal panels mounted to a tile roof several feet apart. Comments still focused on aesthetic concerns. Yet enough consideration was given to this system for the builders to think through system integration and construction issues. Reactions to Photograph 2 included the following:

- *"Wouldn't put it on the front of the house."*
- *"Needs to be flashed."*

- *"May not have the orientation to make it effective."*
- *"There's more things penetrating the roof...there's a place for leaves to collect."*
- *"You don't have a way to get up there to service that without walking across that tile. You're gonna break them [the roofing tiles]."*
- *"The pipes connecting that kind of distracts from the house... you look at the house and it's the only thing you see."*
- *"That's better...when it starts looking like a couple of skylights."*

Photo 3. The third photo showed a single glass and metal panel mounted to a tile roof. In this case, builder comments were primarily positive though they were not completely convinced that it was the perfect system. Reactions to Photograph 3 include the following:

- *"It's integral with the roof."*
- *"That's a good looking unit. It looks pretty much like a skylight."*
- *"Aesthetically pleasing...looks like a skylight."*
- *"You're moving up. That's better."*
- *"People are still gonna know that that's not a skylight."*
- *"That would be okay, but I doubt it's doing very much for that house on a month-to-month basis."*
- *"That doesn't offend me."*

Their expectations that solar water heating systems would be unattractive were confirmed by Photographs 1 and 2. The ideal system would be invisible and not be seen from the street or would look like some other 'upgrade' building component such as a skylight. They anticipated this would lead to increased acceptance by community associations and home owners. Several suggestions were made that SWH manufacturers should work with roofing material or skylight companies to develop these types of building integrated products.

Concerns were raised about the impact a SWH would have on the construction process and additional labor costs from several trade contractors.

> *"It basically slows down the whole house... different trades come in ... and everybody has to work together."*

> *"You're gonna have more cost putting it in like a skylight, you're roofer's gonna charge you more to flash it in... the plumber to tie it in..."*

D. Technical and Economic Performance Criteria

Builders were asked to describe their technical and economic performance criteria for solar water heating.

Table 6: Builder Technical and Economic Performance Criteria

Technical Criteria	ORLANDO, FL		PHOENIX, AZ	SACRAMENTO, CA	
	Move-up Builders	Custom/ Luxury Builders	Move-up Builders	Move-up Builders	Starter/ Entry Level Builders
Code acceptance		●			
Current contractor installs				●	
No leaks	●	●		●	●
Looks like skylight				●	
Low Maintenance	●	●	●	●	
Reliable	●	●		●	●
Simple technology		●			
Timely repairs/ service			●	●	
Quiet		●			
Small collector	●	●			
Standard tank size		●			
Wind resistance	●				
Warranty			●		

Technical Criteria

In the discussion of technical criteria, no mention was made of efficiency, capacity, or recovery time; builders were more interested in the basic performance issue that solar water heating will work and not cause them additional difficulties over time.

Predominantly arid, Arizona was the only location where builders did not list no leaks at the top of their technical criteria list. Reliability and low maintenance are clearly related; when taken together, these two technical criteria were listed in each city.

Economic Criteria

First Cost. Starter home builders were very sensitive to first-cost issues. They felt that SWHs were expensive and did not provide enough monthly savings to make sense to their customers. They noted that rebates were effective even if they required additional paper work, because rebates allowed them to give their customers a home with lower energy bills. If they were comfortable with the history of a product and could increase their profit by $1,000 per custom home or $100 on a production home, they would install the new product.

> *"So if we're gonna put something into that house, it's coming out of our bottom line or whatever profit that you hope to make when it comes to things like this. Again, unless the buyer's willing to pay more for it, it does us no good."*

"Some people were convinced [SWH] was great, but it cost $3,000 to $4,000 to put in the system and at the time, at the peak, the tax breaks represented 95 percent of the cost of the system and so it didn't take much to make the thing pay off. But we ran some calculations and your grandkids would almost have to live in the house forever for it to pay off without the tax break...It might save you $10 a month."

Move-up builders suggested that solar water heating could gain *"a market niche in the area of energy efficiency if you could prove how much it saves or could save."* There was a perception that solar water heating was not cost effective and that it made little difference in a home owner's energy bill. They felt the market that was established with the government tax rebates on SWHs did not sustain itself because the solar industry did not prove a savings. They did not believe the solar industry would be successful without rebates.

Table 7: Builder Perceived and Reasonable Costs

Economic Criteria	ORLANDO, FL	PHOENIX, AZ	SACRAMENTO, CA	
	Move-up Builders	Move-up Builders	Move-up Builders	Starter/Entry Level Builders
Perceived SWH Cost	$2000-$3000	$2000-$5000	$1500-$3500	$3000-$4000
Reasonable SWH Cost	$300-$1000	$1000	$1500	Less than $1000

Cost. There was generally a limited understanding by builders about the costs for currently available solar water heating systems. They perceived SWHs were significantly more expensive than what the industry quotes. Several move-up builders felt that home owners liked to talk about being environmentally conscientious but were not willing to pay more for environmentally-friendly products.

"It's nice to be politically correct, but the bottom line is that people don't care enough about the environment and are not gonna pay more for it."

"What's out there is junk unless you spend $15,000."

"You go to the home buyer and say, 'We'll give you a solar water heater, but you'll have to cough up another $5,000', and they say, 'No way'."

Most of the move-up builders in the highly competitive Phoenix market suggested they would be willing to offer a SWH as an optional feature at a cost of $2,000. Several builders would be willing to offer it as an included feature up to the $1,000 price point but if the price were higher, it would hurt their competitiveness. Providing a SWH as an included feature was considered to be a way to establish market differentiation.

"As long as I can make money on it, I would offer it as an option no matter what it costs."

"My price has either got to be better or I've got to have a reason to pull them in...so if I can say, 'Hey listen, come see our product because I'm gonna throw in this system', then I'd probably pay as much as $1000."

Payback. Most move-up builders believed that quick recovery of the initial investment was nearly as important as first cost. They thought customers wanted to know how much they were saving each month and that there was no information available to prove that $20, $30, $40, or $50 would be saved per month.

Custom/luxury home builders felt that although cost was important, their customers were less concerned about first costs, payback and cash flow than other market segments would be. Move-up builders suggested that the price of SWHs should be closer to conventional systems. They viewed monthly cash flow and payback as the same concept.

E. Builder Perceptions of Home Buyers and Contractors

Home Buyers

Table 8: Builder Perceptions of Consumer Concerns

Consumer Concerns	ORLANDO, FL		SACRAMENTO, CA
	Move-up Builders	Custom/Luxury Builders	Move-up Builders
Reliability			•
Environment	•	•	
Resale			•
Company Image			•
Popularity		•	
Reduced Dependency on Utilities		•	
Aesthetics		•	

Reliability. Consumers did not want to think about their water heating system, nor did they want to worry about maintenance; they wanted to turn on the faucet and have hot water without thinking about it.

The Environment. Builders perceived that, although consumers were interested in the environment, many were more concerned with cost, reliability, and aesthetics. They agreed that the environment was important, but were not aware that SWH was available to them as an option. One respondent stated that consumers were not convinced that other water heating systems were unfriendly to the environment. Some other consumers were very concerned about the environment, and were willing to have the SWH system regardless of cost.

"One [customer] was really environmentally conscious to the point that they don't care what it costs."

Resale. Move-up builders in Sacramento said that consumers were concerned with how they would be able to resell their homes with a solar water heating system—they were not as concerned with getting a positive reaction from the SWH, but they did not want it to detract from their home at all. One builder stated that consumers asked *"How am I going to resell it...if you're in the business and you're having to try and sell me on it?"*

Strong Company Image. Many consumers were concerned that the SWH company would not be around for long; they wanted a strong warranty to assure them that the system was reliable, and they wanted a recognizable company name.

Popularity. Many respondents stated that consumers would be more likely to buy a SWH system if their neighbors had one.

Reduced Dependency on Utilities. Respondents in two focus groups stated that consumers would like to be independent of utility companies. One respondent stated that consumers would like to have hot water during "brown-outs."

Aesthetics. This was very important to consumers, almost as important to reliability, according to one respondent. One stated that consumers would want the system "up on the roof and out of the way."

Other perceptions about home buyers included the belief that consumers were uneducated about solar water heating in general—first time buyers were not aware that it was an option and other buyers often did not ask about their water heating system at all. One respondent stated that consumers were aware of solar water heating for pools, but not for homes.

Contractors

Installation. The builders did not agree on who should install SWHs. Both move-up and custom builders in Orlando thought that specialty contractors should install the system. They believed that most specialty contractors were reliable and that contractors that were already installing SWHs for pools could also install them in homes, but that the installation process would have to be simplified. Custom builders in Orlando were undecided about whether plumbers should be involved in the installation process. Custom builders in Orlando felt that the installation process needed to be simplified and standardized. Move-up builders felt that certification would lead to increased cost.

"You want something that is really universal in installation principal and practice."

Starter builders in Sacramento felt that existing contractors should install SWHs instead of a new contractor that might go out of business. They felt that if plumbers installed SWHs, they would want a manufacturer that would stand behind its product, and that would provide a

warranty and customer service. Move-up builders in Phoenix agreed that a large plumbing firm with an established reputation would be the ideal contractor to install a SWH system.

Effects on Trade Contractors. Builders also disagreed on which existing contractors would be affected by the installation of a SWH system. Move-up builders in Orlando believed that solar contractors would only have to interact with plumbers, who would bring water lines into the house for connections, but the plumbers would not be greatly affected by solar contractors.

Move-up builders in Phoenix felt that installing a SWH would affect the construction of the roof and cause leaks, and that contractors would prefer the unit on the ground, where it would cause fewer problems. They felt the impact of SWH installation on carpenters and plumbers would be limited.

F. Advice to the Solar Industry

Builders had several suggestions for improving the solar water heating industry. Builders believed that a solar water heating system should have the following attributes:

Improved Marketing

All builders agreed that the solar water heating industry should improve its image and public demand. Move-up builders in Orlando suggested conducting focus groups with women because they were perceived as the decision makers of water heaters among home buyers.

Others suggested that a marketing program would have to *"convince the people that it's not a matter of dollars,"* and *"put the image in the public's eye that this is the thing to have."* The solar industry should increase promotion and consumer marketing. *"The industry has to really market to sell the buyer...that they are saving money in the long run."* Builders also suggested advertising in consumer publications.

> *"The source of all this has to be a rock solid reputation or cohesiveness that says 'Hey our industry is viable, it's here to stay. We know what we're doing, we're professionals.'"*
>
> *"Convince the buyer through whatever means that, 'hey, this is the cool thing to have.'"*

Some builders believed that a partnership with the government could help create this image. *"It's going to have to prove itself somehow in the market over a period of time, maybe three to five years."*

Marketing to builders should also be increased. Solar water heating should be marketed as a tradeoff to meet local energy codes. Builders could be reached through trade shows, brochures, and local distributor-sponsored breakfasts. *"The more we know about it as a*

builder, the more comfortable we are." None of the respondents were aware of any programs to facilitate the purchase of SWHs.

Improved Aesthetics

All builders agreed that aesthetics were important to the acceptance of solar water heating.

> *"I think they'd all do it if it was aesthetically pleasing and we could get it in their budget and it worked."*

Starter/First-time builders in Sacramento suggested making it look like a skylight, window, or part of the wall.

Affordability

All builders agreed that the system must be more affordable to purchase and install or it must demonstrate significant monthly savings.

> *"It should really be [cost] competitive with what we're doing now."*

> *"...it really has to have dynamite advantages of savings to the customer before it's really going to be accepted in mainstream building."*

Move-up builders in Orlando suggested a first cost of $500 to $700 and move-up builders in Phoenix suggested $220. Some builders put emphasis on the need for rebates because they believed that SWH was not economically feasible.

Move-up builders in Sacramento wanted price stability and reliability. Constant increases in the cost of solar equipment would make it difficult to do business and price-out homes:

> *"I don't want them five months from now to raise the price on me after I've sold like 200 units. If you put the system in, you've got to have some reliable cost into the long term."*

Improved Installation

In all groups, respondents were concerned about the difficulty of installation, and advised that the installation process be simplified, standardized, and safe. The system should be technically and mechanically compatible with other systems. One builder stated that the installation should be *"idiot-resistant if not idiot-proof."*

Knowledgeable Contractors

Most builders wanted the installers to be knowledgeable about solar water heating, but did not necessarily want new contractors. Move-up builders in Phoenix and Sacramento wanted

current contractors to be trained by the solar industry, and Starter/First Time builders in Sacramento felt that the contractor *"can't be a specialty contractor. That would never fly."*

Improved Design

Builders in Orlando and Starter/First Time builders in Sacramento discussed the design of an ideal solar water heating system extensively. They suggested that the system have sufficient capacity, simplified technology, and as few controls as possible.

Builders stressed that they would like SWHs to be installed on the ground for easier installation and accessibility during maintenance, to avoid penetrations on the roof, and to protect the collectors in high winds. Other builders suggested placing the solar collectors below the roofing tiles or directly below the roof sheathing; using solar panels to provide some other function, such as the roof on a storage shed; or reducing panel size to correspond to the size of skylight.

> *"The only thing that turned me on was a circulating pump that was run from photovoltaics that you could stick on a loop system and it would turn on and off. You wouldn't have any controls because it's photovolatics. When the sun shines, it generates enough power to run the pump...it's so simple. I loved it, so I'm going to get one of those immediately."*

Other builders suggested that the system should be passive and without the noise of an electric pump. The solar collector should be self-flashed and flush-mounted. It should be attractive and not leak. Ten or twelve design options should be provided for different kinds of homes, and the system should not require maintenance because home owners are more likely to disconnect the system than maintain it.

Incentives/Rebates

All builders except move-up builders in Orlando stated that rebates and incentives should be used to increase interest in solar water heating. Custom builders put emphasis on rebates because they believed that SWH was not economically feasible, but some believed that incentives would encourage unskilled and unscrupulous people to get into the SWH business.

Builders in Sacramento suggested that rebates should be offered by the government or utilities, but builders in other areas felt this would create a false economy.

Product Support

All builders except for Custom builders in Orlando suggested that the solar industry be more supportive of its product through warranties and providing information and support for installation and maintenance. Suggested warranty terms were anywhere from 10 to 30 years. Some builders suggested that the SWH warranty match the warranty for the roof.

"I've got to guarantee the system because when the [original] company is out of business, or my plumbers are out of business, or anybody else, I'm the one that's guaranteeing the system and I'm the one who has to service it if there's a problem. If it were a product that a lot of people were using, then it wouldn't be any different than your conventional system."

Manufacturers must provide reliable service and a dependable supply of parts and information. *"If the manufacturers are going to get behind [SWH], then they need to stay behind it."*

Payback

Move-up builders in all areas suggested that the solar water heating system should provide payback within a short time. Orlando move-up builders suggested a payback time of nine months to five years.

Good Performance Data

Builders believed that the solar industry should provide regionally-based empirical data on the technical reliability of SWH in both high wind and sun conditions. Builders believed that knowing the product history would reduce the feeling of risk.

"I should be able to say [and show] this is what it costs to run a water heater and this is what it costs to run solar." Publish data surveys, available by region, locality, or even climate zone to help convince builders. *"If [SWH] is going to be equal [to conventional systems, then there needs to be] some data the consumer can actually see and believe in. That is really an advantage."*

Reliability

Most builders did not mention reliability outright. However, most were concerned about having a product that was well supported and backed by a warranty (see Product Support page 23).

Builders stated that the system should be able to *"Stand up to the weather" and be "bullet-proof for 50 years."*

Partnerships

Builders also made several suggestions for partnerships including the government, utilities, manufacturers, suppliers, distributors, and builders.

Government. Move-up builders in Orlando feared that federal funding for a SWH program could be unreliable, however, custom/luxury builders in Orlando and move-up builders in

Phoenix and Sacramento stated the opposite. Custom/luxury builders in Orlando believed that a partnership with the government would improve the solar industry's image. Move-up builders in Phoenix believed that the federal or state government should offer a tax credit, and move-up builders in Sacramento believed *"If government rebates were there, then the industry, with today's technology could develop."*

Utilities. Builders in Sacramento believed that the solar industry should partner with utilities. Most said that they *"would like to see the utilities get involved."* Utilities would need to offer some sort of rebate to cover the solar equipment cost or purchase the equipment for the builder. Utilities would be expected to provide warranty and service coverage to guarantee the SWHs that builders installed to compensate for the perceived high attrition rate for solar specialty contractors.

Manufacturers. Move-up builders in Sacramento believed that manufacturers should be primarily responsible for marketing and selling solar products. For a solar program to be successful, it would have to be represented by larger manufacturers that were active within the industry. They named national companies *"like Rheem, Carrier, and Trane."*

Suppliers and Distributors. Starter/first time builders in Sacramento believed suppliers and distributors often provided a forum for builders and contractors to meet with product manufacturer sales representatives and that they could provide the same service for the solar industry.

Builders. Starter/first time builders in Sacramento also believed that builders should be included in pilot programs to demonstrate the feasibility of the systems and generate consumer demand and awareness.

Table 9: Builder Advice to the Solar Industry

Advice	ORLANDO, FL		PHOENIX, AZ	SACRAMENTO, CA	
	Move-up Builders	Custom/ Luxury Builders	Move-up Builders	Move-up Builders	Starter/ Entry-level Builders
Marketing to Consumers	●	●	●	●	●
Aesthetics	●	●	●	●	●
Affordability	●	●	●	●	●
Improved Installation	●	●	●	●	●
Knowledgeable Contractors			●	●	●
Improved Design	●	●			●
Incentives/Rebates		●	●	●	●
Product Support	●		●	●	●
Payback	●		●	●	
Good Performance Data		●		●	
Reliability				●	
Resale Value				●	
Generate Electricity			●		
Partner with Government		●		●	
Partner with Utilities				●	●
Partner with Manufacturers				●	
Partner with Suppliers/Distributors					●
Partner with Builders				●	

III. ARCHITECTS

A. CHARACTERISTICS OF THE GROUP

This group of twelve architects was diverse in their design experience.

Table 10: Architect Characteristics

PHOENIX, AZ Architects
• Eighty percent of the houses they designed were custom homes priced at $500,000 or more that ranged in size from 2,000 to 5,000 square feet.
• Most designed a wide range of building types, including custom and production residential, commercial, and industrial. Four architects had experience designing multifamily housing units, townhomes, move-up homes and/or tract homes.
• One architect designed monolithic concrete domes.
• One architect designed 5,000 to 15,000 square foot custom homes.
• Three respondents designed one to six homes per year.
• One architect acted in an advisory capacity, troubleshooting on a variety of projects for other architects, attorneys, contractors, and manufacturers.

B. WATER HEATING BUSINESS AND DECISION MAKING

Decision-Making Process

Architects considered themselves to be the primary decision-makers in the specification of water heaters. They appeared to have a complete understanding of the issues that impact the water heating decision-making process, including technical issues, however, they did not have a good grasp of the costs involved.

Architects did not view builders as influential since they "*usually agreed with the unit specifications*" of the architect and any price difference was simply added to the cost of construction. Architects also believed that trade contractors had little influence other than providing information on failures or problems. Architects suggested that many water heating system decisions were dependent upon who paid the bill, particularly in multifamily buildings.

> *"Trade contractors rarely have any influence over the decision making of water heater specification. They are able to provide the latest data on systems, including problems, performance, economics, etc. Architects will generally spec it out and builders will make a selection on a brand that fits the specs."*

Cost

Architects stated that the typical size of a residential water heater is 40 to 50 gallons. They believed a 50 gallon electric water heater cost $800 installed, with half of that being labor. Architects agreed with builders that gas units have a higher installation cost than electric units due to venting and gas piping requirements.

However, the size of units installed was considered to be user oriented, related to the number of bedrooms in a home, and the location of the master bedroom. Architects stated that they often over-specified the number and size of water heaters in custom homes, while builders often "*down-sized*" them in production homes.

> *"If a 50 gallon water heater is good, put in a 60 to be sure [in a custom home]. With a production home, it's different. If a 50 gallon is good, put in 40 or 35, whatever is cheapest and you can get away with it without worrying about the phone calls [from home owners]."*

Gas Preference and Options

Ninety percent of the water heaters specified by the respondents were either gas or electric, with a strong preference for gas. They stated that recirculating systems have also become common to meet hot water demands of custom home owners.

Water Heater Attributes

When asked what attributes were most important in the type of water heater installed, respondents listed the following:

- Availability
- Code acceptance
- Home owner preference
- Impact on builder
- Recovery time
- SEER rating
- Size and shape of tank and equipment
- Warranty
- Worker/installation familiarity

Architects felt that appearance of tank and equipment and rebates were not as important to the water heating decision making process. They also believed conventional water heating equipment was not an issue because it was so reliable. They suggested that rebates were not as important to them as architects, though they were aware of the impact of utility rebates on builders.

C. PERCEPTIONS OF SOLAR WATER HEATING

Most of the respondents were familiar with water heating systems because they had specified them in the past. Several architects were specifying solar water heating on their current jobs.

They were asked to give top-of-mind responses when shown index cards. Their responses are shown in Table 11.

Table 11: Architect Reactions to Key Terms

Key Terms	Phoenix, AZ Architects
Active Solar Water Heating	*Roof panels; In Phoenix, Arizona, it is positive. In Flagstaff, Arizona, it's not quite so positive. Protect from freezing*
Electric Water Heater	*Expensive; Simple; Convenient; It's easy, goes anywhere; You don't have to worry about venting them.*
Gas Water Heater	*Ho-hum; Efficient; Normal... Average; If available; Very accepted; We're used to it; Serious; People want that; Problems with multifamily units; Just the hazard of gas; It's half the cost of electric water*
Million Solar Roofs Initiative	*Zero; Federal programs in the 70s... there were some great ideas and there were some not so great ideas... there was substandard workmanship and substandard materials; I thought it was a government program trying to get solar energy on a million roofs... this would be positive if it worked*
Passive Solar Water Heating	*Bummer; Freezing; leaks; panel problems*
Photovoltaics	*Exciting; High tech; Be great if you could afford them; Tough to sell; It's got to be the future; Difficult conversion to usable power*
Solar Energy Industries Association	*I thought it was defunct; If there's gonna be a new solar effort, then we're gonna need a good association to lead that.*
Solar Water Heating	*Good stuff; Not as accepted as it used to be as new installations; Difficult to sell it to people; Complicated; Maintenance; A lot more fittings; Back-flushing*

Electric/Gas Water Heaters. Architects considered electric water heaters an expensive and reliable convenience; great for use in small, difficult-to-access locations but very expensive to operate. Comments about gas water heating centered on its widespread acceptance and its proven track record.

Solar Water Heating. Solar water heating elicited both positive and negative reactions, with negative comments related to maintenance. Active solar water heating was considered appropriate in areas that were not subject to freezing. Feedback about passive solar water heating was rapid and uniformly negative due to perceived maintenance and durability issues.

Photovoltaics. Photovoltaics garnered a strong, immediate, and positive response. They felt high first cost made PV a difficult sell at this time, but viewed it as a high-tech energy source for the future.

Solar Energy Industry Association. Familiarity with SEIA was limited, but one architect suggested that a strong industry association would be key to the success of solar in residential construction.

Million Solar Roofs Initiative. The Million Solar Roofs Initiative brought back negative memories to some architects of past Federal incentive programs. Other architects pointed out, however, that an effort to field solar water heating systems on one million roofs would be great if it were successful.

Restrictions

The architects would be more likely to specify solar water heaters if builders and developers gave them more design flexibility in regard to site orientation. Solar panels were more likely to be used on homes in remote locations where gas was not available and there were no restrictive CC&R's. They felt that solar water heater use was limited because they perceived that *"too many of these subdivisions have heavy restrictions against solar panels."*

Solar Water Heating Attributes

Most Important/Least Important Attributes. Architects stated that all attributes were important to their decision to specify SWHs. Those attributes that were not important were issues that might have importance to home owners or builders. They perceived the cost of a solar water heating system to be $2,700, with $200 being the cost of the conventional water heater itself.

Attributes listed as important:

- Availability
- Code Acceptance
- Home owner Preference
- Impact on Builders
- Recovery
- Seasonal Energy Efficiency Ratio
- Size and Shape
- Warranty
- Worker Familiarity

Attributes listed as not important:

- Available energy source
- Construction sequence
- Monthly cash flow
- Noise
- Rebates

Architects were familiar with several water heater manufacturers including Solar Heart and Sun Systems.

International Issues. The respondents felt that other countries were further ahead of the United States in providing mass produced, more affordable, dependable, low maintenance SWH systems.

"Israelis and Australians have completely different solar water heating systems than we have in the United States. They're much further ahead. They're much cheaper. They're much more dependable. They're self flushing and self-maintaining. They're stainless steel. They have the panels and the storage together in a single unit and they mass produce them. That's one thing that's not happening in the United States."

Placement. Architects suggested that solar water heating was complicated because of placement on the roof and interfaces with the electric, plumbing, and framing of the home. They also stated that the roof panels were not aesthetically pleasing because they were visible. Unlike a conventional system which is in a closet, it will affect the architecture, the neighbors, and the Home owners' Association.

Site Orientation. Architects noted that site orientation was an issue, particularly with production homes, where each house would need a different design on each side. They stated that would require comprehensive planning which was not likely to happen.

Marketing. Architects agreed with builders that there was a need to create consumer demand through a marketing campaign. They perceived a market niche among a younger generation. Architects noted that SWH systems were not designed into the house as part of the house system, nor were they integrated into society's thinking as they had been in the past. Finally they stated that the industry should develop a new name to market the system in order to avoid negative perceptions associated with the current name.

"Younger clients today are more energy-conscious. When faced with the three options of gas, electric, and solar, younger clients are typically choosing solar."

"And if they were of real quality, they could be a forget-about-it and it's-always-there type of thing. But if you put them up on top of the roof and they get the wear of the elements and the CC&Rs and the neighbors and the birds and you take care of it and it makes leaks in your roof... it's not compatible with society and the buildings as we have built them."

Regional Effectiveness and Need. Architects felt that geographic areas where SWHs performed the best were areas the least likely to need supplemental water heating.

"The area where it is most effective, which would be the desert, is the area we probably least need it because the reality is that it takes less energy to produce hot water in the desert because most of our water heaters sit in the garage and it's so hot anyway in the summertime... Chicago doesn't have enough sunny days to make it realistic."

Environmental Impact. Some architects suggested the energy invested in producing SWHs compromised its environmentally friendliness. Architects could not relate to saving 3,000 pounds of pollution per month from the use of SWHs because they found the concept too abstract or found no basis for the measurement. However, they noted that although energy

efficiency was not a topic of interest to their customers, the environment was.

Obstacles. Architects noted that one of the greatest barriers to solar water heaters was the perceived potential for problems. They also felt that code issues and a lack of comparative information were obstacles to incorporating SWHs in more homes.

> *"There's many more potential problems in the solar water heating system from the standpoint of reliability, installation, warranties, call-backs and initial cost. Whereas the electric or the conventional systems, you buy it, you put it in, it's kind of a proven product."*
>
> *"There's an insufficient amount of studies that are common knowledge to the professions as well as the general public of a comparative nature. If the data were available for people to see the different attributes of different systems, that would help in the making of a more educated decision."*
>
> *"Big hindrance are the municipalities... codes are probably the biggest obstacle to the progress."*

Aesthetics. Architects were told there was a law in Arizona architects making any deed, covenant, or restriction that effectively prohibited the installation of a solar energy device was null and void, respondents noted that CC&Rs could make life rough nonetheless.

When asked what they meant by "aesthetics" architects pointed out several problems with the appearance of solar water heating systems.

- *"You can see it."*
- *"It's a different color and it's reflective."*
- *"It is not integrated in any manner to the structure."*
- *"Actually, what it amounts to is it is a nontraditional piece of architecture.' It didn't exist centuries ago and it's not like picket fences or arches... it wasn't invented by the ancient Romans..."*
- *"If it didn't look like a solar water heater, but looked like a window, then it becomes traditional."*
- *"It's a wart."*

D. Technical and Economic Performance Criteria

Technical Criteria

Architects had few technical concerns regarding solar water heating, but suggested they had a difficult time designing homes to accommodate solar collectors. If their technical criteria were met, solar water heaters would be as reliable and unobtrusive as conventional water heaters. They described their technical performance criteria as follows:

- *"Being able to forget it."*
- *"It works everyday for the rest of your life."*
- *"You don't think about it."*
- *"Has to work for seven years with no maintenance."*

Economic Criteria

Architects had greater concerns about the economic performance of solar water heating than about its technical capabilities. They stated that it should cost the same as conventional water heating systems. They felt that payback was important since it gave the consumer an indication of why they would want to buy the system and what it would do for them.

Rebates and Incentives

Architects felt that tax rebates would be valuable for home owners and equipment rebates would have value to home builders. They also noted that tax rebates were more enticing to consumers than monthly cash flows because gas utility bills are already low. They were not aware of existing tax credit programs in Arizona.

Architects were familiar with energy efficient mortgages (EEMs). They were not sure of their effectiveness, but were glad that energy efficiency measures were being viewed in terms of life cycles.

Cash Flow and Payback

Architects had mixed reactions to the issue of positive monthly cash flow. Many did not feel that monthly cash flow was important to their primarily high-end, custom home clients. One respondent noted that the energy savings equaled the additional mortgage payment so that there were no savings for many years. Others, however, felt it would make a difference in the affordable housing market if the systems did not require maintenance.

> *"A friend of mine put one on his house and it added $30 to $35 to his mortgage. That's how much the water heating bill would be – about $35 a month. I didn't see the savings... no savings until it was paid off in 23 years."*

> *"I think there's a certain economic strata above which monthly cash flow is not an issue... right now solar water heating is on an economic level that is above where people don't care about cash flow. To get solar water heating to be a typically considered item, it's got to come in where it is making a difference to people who don't have the cash flow."*

> *"Solar water heating is a conflict. It is like an oxymoron or something because it's free fuel and it's the most costly thing you can do... it's like a Catch-22. On the lower cost homes, the price is almost prohibitive to putting them on. On the homes that are*

multi-million dollars, usually the cost of energy is not a big concern."

The ability to explain payback to home owners in a simple, easy to understand, and believable manner was a key issue to architects.

> *"Payback has always been important. It's just that some people aren't believing in it now days."*

> *"If you want to get it to the masses and sell a lot of them, go back to the payback. Explain it and in very short sentences."*

E. Architect Perceptions of Home Buyers and Contractors

Home Buyers

Types of Consumers. Architects noted that there are different types of consumers, some of which were more likely to express interest in solar water heaters than others:

> *"People either see it as important or are money driven and they see it as some means of saving...well, maybe seeing some independence from SRP [the local utility company] or some other electric bill. To others it makes no difference whatsoever. They just ask if it is reliable. You can see them divided into two camps every time... there might even be a third category. It's the one that hears that 3,000 blah, blah, blah [pounds of pollution saved] and puts all kinds of weight to that... and whatever it costs and however unreliable it is, they want the panel there so that everybody knows that they're doing their part."*

Aesthetics. Architects suggested that aesthetics were everything to consumers since *"how we are judged by our neighbors becomes very important, and, of course, that reflects on solar panels because it's part of the system. What are the solar panels going to look like? It is almost as important as how it is going to work."*

Maintenance. Architects suggested that consumers want a system that they do not have to think about or maintain.

> *"The home owners were never educated as to what needs to be done for the maintenance. They want it to be up there and work... the home owner has to get involved with their solar system more than they do these other systems."*

Monthly Cost. Although architects had mixed reviews of the effectiveness of positive monthly cash flows to convince people to purchase SWHs, they stated that consumers wanted to know how much their costs would be reduced on their next utility bill.

Popularity. Architects felt that Americans did not want all of their houses to look the same, but if their neighbors had a solar water heating system, they would be more likely to want one.

> *"If everybody else had it, then it would be acceptable on that street."*
>
> *"In the 70s and 80s, people were smart or they appeared smart if you had one... and now solar water heaters have a history attached to it... now it is not smart."*

Contractors

Architects did not discuss contractors to any great extent. They noted that the installation was complicated involving plumbers, electricians, roofers, and framers. They suggested that these trade contractors thought solar water heaters were "*a pain in the neck.*"

F. Architect Advice to Solar the Industry

Architects noted that a solar water heating system had to be significantly better than what they were already familiar with. They suggested that the word "solar" not be used in the product because of its negative image. Respondents suggested that there were existing utility programs, but they were not familiar with Home Energy Rating Systems.

Attributes of a Solar Water Heating Program

- Aesthetically pleasing products
- Consumer awareness
- Guarantees on installation
- Industry standards
- Information to client
- Manufacturer approved installers
- New name
- Reasonable Payback
- Reliability
- Support of State Governments
- Support of Air Quality Boards
- Tax rebates
- Unique system overcoming perceptions
- Whole house integration

Partnerships

Government. Architects had mixed feelings about the involvement of local or state governments. Some felt that was the only way to get tax credits which were viewed as effective, while others felt that manufacturers should lead the way with ingenuity.

Manufacturers. They stated that partnerships should include a manufacturer with national brand-name recognition.

Utilities. Respondents were aware of existing utility programs, but they were not familiar with Home Energy Rating Systems. They suggested that utilities should lease SWH systems.

"Maybe the utility company should take charge of this and perhaps lease us the stuff. You can buy this and you can start taking $20 right off your bill this month. We buy the system and install it and you pay so much a month for it and you get a rebate on your bill immediately. Then when you sell the house, the system goes back to the utility company or it can remain with the house so they don't have that initial impact of $3,000 to $5,000."

Improved Image

Architects advised that SWH manufacturers should design a new system to overcome their associations with past systems. Manufacturers should also have a proven history or track record with other products. They would like to show their customers installed systems and if the systems proved unreliable, they would like a money back guarantee. Architects made the following suggestions for improving solar water heating's image:

- Generate conversation about solar water heating and make it part of the culture.
- Conventional solar water heating systems should not be seen.
- Get the collectors off the roof to avoid potential roof leaks, maintenance difficulties, and damage to the roofs.
- Design collectors that capture heat from the driveway, a path of concrete tiles, a metal roof, or another exposed location.
- Design a whole-house radiant heating system where materials all around the house are embedded in the architecture and capturing heat.
- Design collectors that look like gutters or another existing housing product until they are accepted.
- Create solar panels that are part of and integrated into the roof framing system.

"If it were a gutter or the hips, it wouldn't introduce new lines... a new material usually is made to look like an existing material to become accepted. And then eventually it takes it's own personality."

IV. TRADE CONTRACTORS

This section discusses the opinions of trade contractors with and without solar water heating experience in solar water heating.

A. CHARACTERISTICS OF THE GROUPS

Table 12: Trade Contractor Characteristics

SACRAMENTO, CA	
Trade Contractors without Solar Water Heating Experience	**Trade Contractors with Solar Water Heating Experience**
• Nine respondents • All were active in the residential market • Three respondents were roofing contractors • One roofing contractor was heavily active in the commercial market, for both new construction and re-roofs • One roofing contractor specialized in stone-coated steel-tile roofs • Two respondents were general home improvement contractors working on roofing, siding, insulation, and window installation • Two respondents were heating, air-conditioning, and plumbing contractors active in both the residential and commercial markets • Two respondents were exclusively plumbing contractors • Respondents worked on homes from $60,000 to $400,000	• Eight respondents • Two respondents were plumbers who did new residential, repair and remodeling, and commercial work • Two respondents were roofers with residential, commercial, and industrial experience • Four respondents installed, serviced, and sold solar systems for residential and commercial applications including swimming pool heaters • Three respondents were proprietors of their own businesses • All respondents averaged approximately 20 years experience in their trades • Current new residential construction activity ranged from less than 5 percent to more than 50 percent of the respondents' total business

B. WATER HEATING BUSINESS AND DECISION MAKING

Most contractors thought the General Contractor was the key decision maker, especially in production and custom homes, and their decisions were based on cost.

Cost

Contractors suggested that the installed cost of 40 to 50 gallon gas water heaters ranged from $600 to $1,200, and varied due to flue installation costs and/or code regulations. They suggested half of the cost was for labor. Contractors stated that the monthly cost to operate a

gas water heater was $12 to $15 while operating costs for electric water heaters was less clearly understood but significantly higher.

Gas Preference and Options

Most trade contractors indicated clear preferences for gas water heaters, citing reasons of cost and operation. Respondents with limited experience claimed that 90 percent of the current water heater market was gas, and that electric water heaters were "*only installed in new construction*" when there were structural or architectural limitations to gas. Some respondents noted that larger capacity tanks with preset temperature settings were being installed to reduce the chance of scalding injuries.

Installation

Contractors noted a trend that larger water tanks and multiple water heaters were being installed in both new homes and remodels to complement added hot water dependent conveniences and upgrades desired by consumers. Optional upgrades to water heating systems included 75 gallon tanks, recirculating systems, and hydronic and high recovery rate units. Twenty or 30 gallon electric units could also be installed for individual showers or where there was limited space. Plumbers commented that they recycled the water heaters that they removed to avoid the waste disposal fee. They were paid a token amount by the recycling center for the units they brought in.

All trade contractors that had some experience with water heating options were familiar with SWH systems. They immediately noted, however, difficulties and frustrations with these SWH systems.

> "*If a water heater goes out, the customer is out of hot water for weeks. I have people who want a regular back-up water heater because with the solar water heater you've got to wait for the parts to get in from the manufacturer.*"

Home Buyer

Contractors without SWH experience said the home owner was a key decision-maker, especially in the custom home and repair and remodeling markets. They also noted that home owner influence was more evident today since buyers "*are a lot more educated*" than they were fifteen years ago. Most contractors saw this as an advantage, stating that it saves the contractor time and money, and saves the customer "*dissatisfaction in offering our service.*"

Plumbers

Contractors with SWH experience identified plumbers as the key decision makers in the repair and remodeling market. The plumbers in the group agreed that customer service from

major manufacturers was important and specifically mentioned American, A.O. Smith, Rheem, Sears, Standard, State, and Wards.

Experienced contractors identified architects as indirect decision makers for custom homes since they designed the energy system specifications.

Trade contractors cited cost, environmental image, hot water delivery and recovery time, and impact on builder reputation as the most important attributes in making decisions regarding water heaters.

On the issue of reliability, contractors said "*You don't want to have to come back two or three times to change that water heater. You only want to do it once along the way.*" The stated warranties should be "*five years on the tank and two years on parts.*"

Table 13: Contractor Most Important Water Heater Attributes

Most Important Attributes	SACRAMENTO, CA	
	Trade Contractors without solar water heating experience	Trade Contractors with solar water heating experience
Availability of parts	•	
Codes and regulations	•	
Cost to purchase and operate	•	•
Efficiency		•
Environmental image	•	
Hot water delivery	•	
Impact of builder reputation	•	
Insulation rating		•
Manufacturer and brand name recognition	•	•
Rebates available from utility company	•	
Recovery time	•	
Reliability		•
Safety of water heating system	•	
Size of tank	•	
Warranty length and conditions	•	•

Table 14: Contractor Least Important Water Heater Attributes

Least Important Attributes	SACRAMENTO, CA	
	Trade Contractors without solar water heating experience	Trade Contractors with solar water heating experience
Appearance of water heater system	•	•
Manufacturer and brand name recognition	•	
Noise		•
Special worker training		•
Use by other builders		•

C. Perceptions of Solar Water Heating

Important versus Least Important Attributes

Contractors in both groups agreed that costs to produce and operate, manufacturer, brand name recognition, and warranty length and conditions were important attributes. They also agreed that water heater appearance was not important.

Price. Contractors suggested that a passive solar water heating system costing $3,200 before incentives was considered to be the most effective from May to October with a monthly savings of $30 to $140 per month.

> *"SMUD had a program where you could get into a passive or glycol type of system, if you had an electric water heater, and they would finance, give you a rebate of between $800 and $1,000."*

> *"The home owner wants to see a dollar savings."*

Contractors without solar experience believed SWH systems ranged from $3,000 to $10,000.

Contractors were also concerned about the cost of removing a solar water heating system, and stated that the price to remove a non-functioning SWH was approximately $150 for three hours of labor.

Repair and Replacement. Many of the respondents had experience with the repair and replacement of inoperative solar water heating systems. They stated that a high percentage of systems had been disconnected but were still on the roof. Roofers and plumbers commented that 50 percent of the solar water heating systems they encountered did not work.

Noise. Noise was not important to roofers but was important to plumbers because they responded to home owner complaints. Plumbers also valued specialized training more than the other respondents because they performed the installation.

Table 15: Contractor Reactions to Key Terms

Key Terms	SACRAMENTO, CA	
	Trade Contractors without solar water heating experience	**Trade Contractors with solar water heating experience**
Active Solar Water Heating	*It's that word 'solar' that I don't like*	*You've got to know what you're doing; Efficient; Better warranties; More maintenance; Equipment better now than it was 10 or 20 years ago*
Electric Water Heater	*Expensive; Cost of operation; Warranty*	*Dinosaur; Anachronism; Slow recovery; Change it out*
Gas Water Heater	*Most efficient; Most common; Preferred product; More money; Higher cost to install it*	*Most efficient; Quick recovery; Affordable; Clean; Gets a leak and blows the house up*
Million Solar Roofs Initiative	*Political jargon*	*What the hell is that?; Federal government program; Here we go; For both electric and solar; Video conference next month*
Passive Solar Water Heating	*It's tired*	*Good system; Low maintenance; It works; Less things to go wrong; There's still quality issues with passive*
Photovoltaics	*Not proven; High-tech*	*Future source; Future; It's not so futuristic; I can't even get solar electric panels there's such a demand for them that we're having a hard time getting orders filled*
Solar Energy Industries Council	*A bunch of bull; Got a ways to go*	*Member; Industry Association; Never heard of them*
Solar Water Heating	*Pain in the butt; Solar went out with the rebate system*	*Panels on the roof; Co-generation; Large commercial water systems; Future; Down the road*

Life Expectancy. Most contractors without SWH experience thought the average life expectancy of solar panels and solar equipment was seven years.

> *"You go up on the roof and look at the solar panels and they're shot. They are so broken that we can't get them off the roof. Seven years is about their life span. Seven years and they're brittle."*

Recovery Time. There was a general perception that hot water recovery time for SWHs was longer than conventional gas and electric water heaters. Conventional back-up systems were perceived to be necessary, *"especially for cloudy days."*

"Recovery time should be equivalent to what a gas or a conventional water heater can put out, but they're not. You get a nice hot sunny day and it works fine. You get a bunch of cloudy days and stuff like that and they just don't do it. It does not have enough back-up to deliver what a normal conventional water heater would give out."

Warranties. Most trade contractors believed that warranties were an important and necessary feature of SWHs, but were skeptical that solar companies would be in business long enough to honor them.

Installation and Repair. Many contractors perceived that SWHs were complex to install and difficult to repair.

"They're a headache for everybody. A lot of people can't work on them. Even if you do know how to work on them, you can't get parts for them. You've got to be a rocket scientist to figure it out."

Contractors thought roof designs on contemporary homes were large enough to accommodate solar panels and equipment, but building code requirements and CC&Rs were more significant limitations.

"If the regulatory or code inspection wherever you're located is not going to accept their installation, then they're not worth anything. Another thing is now your newer home developers will not allow anything on the roof. CC&Rs are put together by the developer of the land and they stay with the property. The CC&Rs spell out what someone can do and what they can't, and roofing is one of them."

Aesthetics. Contractors without SWH experience believed that the aesthetic appearance of solar water panels was a major concern for home owners and their neighbors. They suggested that solar equipment stood out *"like a sore thumb"* and was often considered *"an eyesore."*

Contractors with solar experience agreed that SWH aesthetics were a significant market hurdle. Contractors don't think builders and consumers should have to compromise aesthetics. Many community's CC&Rs prevent or restrict the use of thermal collectors based on aesthetics.

- *"It shouldn't [look like anything]."*
- *"Most people would like to not see them. It should look like your roof."*
- *"I guess appearance on solar systems is really important."*
- *"There are a lot of Home owner Associations that don't want it [a solar water heater] on the front of houses."*

Table 16: Contractor Most Important Water Heater Attributes

Most Important Attributes	SACRAMENTO, CA	
	Trade Contractors without solar water heating experience	Trade Contractors with solar water heating experience
Appearance of panels and equipment	●	●
Codes and regulation acceptance	●	
Cost to install and operate	●	●
Consistent availability of energy source	●	
Environmental image	●	
Hot water delivery and recovery	●	
Pay-back period/visible cost savings	●	●
Reliability		●
Safety		●
Size of panels and equipment		●
Space limitations	●	
Warranty length and conditions	●	●

Table 17: Contractor Least Important Water Heater Attributes

Least Important Attributes	SACRAMENTO, CA	
	Trade Contractors without solar water heating experience	Trade Contractors with solar water heating experience
Appearance of panels and equipment	●	
Builder reputation		●
Construction sequence	●	
Financing		●
Noise		●
Rebates		●
Size of panels and equipment	●	
Use by other builders		●

Government Involvement. There were both positive and negative reactions to the Million Solar Roofs Initiative that led to a lengthy discussion about the government's role in the solar industry. There were negative recollections of past incentive programs and a feeling that free market forces dictated product manufacturers that take the lead in building the market. Respondents suggested the government should establish standards for products and installers, do basic research, and create awareness through education.

"It opened up a flood of unscrupulous contractors... and that's one thing I'd be afraid of if the government started doing incentives like this that I'd rather see as an individual manufacturer, company... free market."

"Just a couple of things regarding the Million Roofs Program. If the people you represent are involved in that... [they should] state that anybody that wants to use this program must use an approved contractor that's been in the business for over three to five years."

"Try to eliminate these people who are just waiting for the next government program. There has to be a way to keep the fly-by-nights from screwing up the deal."

Reactions to Photographs. Experienced trade contractors were asked to score and give their reactions to a series of photos of SWH installations. Their reactions were immediate and focused on aesthetic and maintenance issues. They suggested that the SWH not be placed on the roof at all.

Photo 1. The first photo showed a combined solar/photovoltaic system mounted to a rack standing several feet above the plane of the roof. The respondents scored this system between zero and five points on a ten point scale.

- *"It looks like the space shuttle Atlantis parked on a guy's garage."*
- *"I think it's a negative just because of the way it is located. It's pitched like that..."*
- *"Somebody designed the front of that house for appearance, for curb appeal to come up there and then all of a sudden, here you've got a big black panel sitting up there because they couldn't get it right."*

Photo 2. The second photo showed two rectangular glass and metal panels mounted several feet apart to the top of a tile roof; it was given a score of five to six out of ten.

- *"It looks like an ideal installation. It just looks like a couple of skylights."*
- *"I think that what makes this more acceptable is it's a flush mount system as opposed to the dual pitch, side raised."*
- *"The only thing that could improve that would be if there was a way to tie those panels together underneath the roof."*
- *"If you have maintenance you've got to get on the tile roof and you're going to break tile getting to it if you don't know how to walk on it."*

Photo 3. The third photo showed a single glass and metal panel on a tile roof; it was given a score of eight out of ten.

"An Integral Collector Storage... that's the technical name for them. [They hold] from 30 to 50 gallons – they are heavy – 260 pounds empty, about 600 pounds up

there so you really got to figure out the anchoring. You talk about a load, that's a real load."

"It's very efficient, low maintenance" and *"it was flashed in properly."*

D. Technical and Economic Performance Criteria

Standardization

Many contractors with solar water heating experience felt product standards, certification, and labeling were a way to reduce uncertainty about product performance and durability. They suggested that an independent, non-profit entity should provide this service. They suggested using Solar Rating and Certification Corporation and certified contractors.

"You had to apply to be a contractor in their [SMUD] program.

Installation and Maintenance

Most contractors without solar experience were concerned with the installation and maintenance of solar water panels on roofs. They emphasized that plumbers should be the trade installing and maintaining SWHs due to their experience with gas and electric water heating systems. They also stated that plumbers were usually the first to receive calls when *"something goes wrong"* with SWHs and the original installer *"went out of business."*

Design

Both plumbers and roofers among the contractors without SWH experience had concerns about flashing on the roof where SWH equipment was installed, suggesting that current mounting and flashing procedures were inadequate and deteriorated too quickly; making re-roofing and equipment maintenance difficult. They noted that specifications on mounting and flashing would *"simplify the work of the roofer."* Respondents felt that there were better ways to address the issue of panel attachment, including a system of securing steel plates and pipes directly to the rafters through the roof sheathing.

"We can flash it just like all the rest of the pipes on the roof, and then you just run steel between the pipes and it's all bolted together, it's all steel, and it's going to last as long as the roof."

Contractors with solar experience discussed design issues related to the Sacramento climate, which is severe enough to require that SWHs be winterized and protected from freezing. *"Need a system that doesn't freeze."*

Economic Criteria

Trade contractors had mixed reactions on the issue of positive monthly cash flow regarding solar water heating systems. They felt the concept was important to consumers but was difficult to quantify. They had expectations of a high first cost, but believed that solar water heating could compete economically with conventional gas and electric water heating systems.

Payback. Trade contractors suggested that for solar water heating to be competitive, it would have to be cost effective and have a relatively short payback time of two to seven years. They also wanted a way to figure and demonstrate payback to their customers easily.

> *"If you were going to buy a gas water heater for so much money, and you were going to buy a solar water heater for probably eight or ten times that amount, you better make back that amount. I'd want to be convinced that I'm going to see my money back in two or three years. If you don't get your money back out of that system in savings for seven years, then why would you do it?"*

First Cost. Most contractors without SWH experience felt that $1,500 would be the ideal cost for a solar water heating system. They said that if a customer really wanted a solar water heating system, he or she would pay up to $2,000.

> *"At $2,000 they'd consider it. At $1,500, they would probably grab it up. They'd go for that, as a whole kit."*

A few contractors with limited experience suggested that prices for solar water heating systems would have to be around $800 in order to compete with gas and electric water heating systems in the cities and the Sacramento Valley.

E. Contractor Perceptions of Builders and Home Buyers

Builders

Trade contractors with SWH experience limited their discussion of builder expectations to the practical considerations of product cost, reliability, and availability of parts for repairs. They suggested that a SWH would be evaluated like any other element installed in a house – simply being a good value and delivering its intended function. They also recognized that builders would expect the various trades impacted by solar water heating to coordinate their work to ensure proper installation of the system.

- *"Everybody's got to touch it in one shape, matter or form."*
- *"They look at the bottom line like most. They are consumers just like everybody else."*
- *"They don't care as long as it works."*

- *"If you need something... for some reason something didn't quite work out on that system, you need to get a part for it, by God, you want to be able to get it in a few days not eight weeks later or three months later."*

Home Owners

Trade contractors believed that there was a market for solar water heating, but for home owners to support it, the system would have to be cost-effective, affordable, and provide a sense of value in the long run and eventually reduce dependence on a utility company. They suggested that even the environmentally friendly attributes of solar water heating were less important than the economic considerations.

- *"[The manufacturers] are not going to sell solar water heating without addressing this issue. It has got to be affordable."*
- *"People are more value conscious today rather than price conscious. Price is obviously an issue, but you need to sell value rather than price."*
- *"If you pay $4,000 for a solar water heater and $1,000 for a regular water heater, within five to ten years you should get that other $3,000 back in savings or its not worth it."*
- *"I'm waiting for the day when I can start selling electricity back to PG&E instead of sending it all in."*

SWHs would have greater value to home owners if they supplied enough water for domestic use and heating the home. There would also have to be a high level of commitment to the system from the manufacturer and the installer. Customer satisfaction was perceived to be a "*concern that lasts forever*" and a strong component to the acceptance of solar water heating.

> *"The general concern with a customer out there is 'is this company going to last?'. They want commitment. Someone they can rely on years down the line when the product starts falling apart."*

F. ADVICE TO THE SOLAR INDUSTRY

Trade contractors developed an extensive list of suggestions to manufacturers for the 'ideal' solar water heating system, including a high efficiency rating, installation instructions, a lifetime or extended warranty, a low price, a proven, low-maintenance, low weight, system, and having an official certification rating similar to that given to conventional water heaters.

Marketing. Contractors generally believed that manufacturers should be the leaders in establishing a program encouraging the use of solar water heating that "*gets these systems out there*" into the marketplace. An effective program would focus on various issues, ranging from affordability and appearance to equipment durability, financing options, and building codes.

Proven System. Contractors suggested that a solar water heating system should demonstrate that it pays for itself in a given amount of time and "*with a positive monthly cash flow.*"

Aesthetics. Contractors stated that manufacturers need to work toward making solar water equipment more aesthetically pleasing by integrating the panels into roof designs to increase community acceptance.

Affordability. Solar water heating should be more affordable to install and maintain to allow it to compete with conventional gas and electric systems.

Installation. Respondents suggested that accurate installation diagrams or cut sheets need to be distributed to each contractor in a pre-construction meeting. Some felt that manufacturers avoided being very precise with installation details to limit their liability should problems develop.

Technical assistance. Contractors felt that manufacturers needed field-trained technical representatives to provide more direction on proper installation and building code compliance.

> "*We certainly need to have someone who is not just some pencil pusher. We need to have someone that knows hands-on how it works, or at least do their research ahead of time and not just put it on paper.*"

Inspection Services. A standardized inspection program was thought to be important by trade contractors.

> "*Have a good inspection program to make sure it's installed right by a licensed contractor... it's got to be monitored.*"

Design. Respondents believed that new design innovations allowing solar panels to be installed in places other than the roof would enhance the acceptance of solar water heating. They suggested that solar panels should be installed at "*the bottom of the eaves of a roof that was accessible for everybody*" and would eliminate the need for walking on roof tiles.

> "*Solar panels don't always have to be on the roof. Nine times out of ten you're not going to get sunlight but on one side of the house at a time. You could put it at the eaves of the roof and that would make it a lot easier than having to put it up in the middle of the roof. It could go right where the fascia is, all the way around.*"

Commitment. Manufacturers should maintain a long-term commitment to solar water heating products and programs. Financial support should include capital to launch new programs and products, and supporting them through all aspects of development and application. Commitment should include encompassing any necessary changes needed to maintain solar heating as a viable industry.

Insured Warranty. Manufacturers need to establish and provide effective warranties that could be supported by third parties like an insurance policy to protect purchasers from faulty equipment, part deterioration, and manufacturer bankruptcy.

> *"Provide a good warranty. Not just one that is backed up by the manufacturer that's going to go 'poof' in a year, but something like one State Farm could support, like an insurance deal."*

Partnerships

Trade contractors agreed that a partnership for the establishment and advancement of solar water heating programs would require the involvement of government, utilities, product manufacturers, trade associations, and trade contractors.

Government. Contractors without SWH experience had a negative view of public sector involvement in establishing a solar water heating program. They felt that the private sector should be primarily responsible for managing and promoting solar water heating through utility and/or manufacturer subsidies, but also realized that the private sector would not pursue such a program on their own unless it was "*profitable*." Experienced contractors on the other hand, felt that a successful program would require the involvement of both the public and private sectors.

Utilities. Experienced trade contractors agreed that a local utility should have a central role in a solar program. It was not clear to them what that role should be, though inspection, promotion and marketing were suggested.

> *"SMUD (Sacramento Municipal Utility District) should help promote it but I don't think they should control it."*

Manufacturers. Contractors stated that an established, nationally-recognized and trusted manufacturer of appliances, HVAC equipment or gas and electric water heaters, should be in charge of running a solar marketing program. They cited name recognition and credibility as key to "*speeding up*" the acceptance of solar water heating. Some companies specifically mentioned were General Electric, Lennox, Rheem, and State.

> *"They would have to have an established name. Anybody who's been around a while. I think a major national brand would help immensely because they'd get instant recognition and credibility."*

State Commissions and Trade Associations. The California Energy Commission and trade associations were looked to for the provision of education and possibly inspection services.

> *"[The government and industry associations] should be the educators of both field inspectors and installers, and of the people who are buying the solar water heaters."*

Trade Contractors. Respondents suggested that they were willing to work directly with solar manufacturers to help identify necessary installation details and "*create a useful team*" of plumbers, roofers, builders, and manufacturers to install systems that work.

> "*We would all be able to learn how to put them in and to do it right without making it a nightmare.*"

Trust. Establish and maintain trust with all parties involved in the solar water heating industry, including builders, contractors, architects and home owners.

> "*Trust has got to be in there somewhere. If I could believe in the product, I could sell it.*"

V. CONCLUSIONS

- One of the largest barriers to the adoption of SWH is builder and buyer satisfaction with existing gas water heaters; they provide the desired recovery time and are perceived as reliable.

- Past state and Federal incentive programs, where a number of contractors entered the market just to save money, created negative perceptions of SWH which must be overcome. Architects noted eliminating the term 'solar' would change negative associations with the historic product.

- Builders considered themselves the primary decision makers for water heating systems. They will react to market demand and will build what their customers want; they do not perceive the market demand now. Architects were influential in the high-end custom market; they were relatively knowledgeable and open to SWH. Plumbers wanted to be the trade responsible for SWH installations since they have many of the necessary skills.

- Builders were willing to offer SWH as an option. They had a successful track record with other water heating related options and upgrades.

- Durability and maintenance were among builders greatest concerns; they wanted to avoid roof leaks and service calls that they perceived as being prevalent with previous systems.

- Appearance was not a consideration for traditional water heaters but, was the largest concern for SWH panels since they are visible when mounted on roofs. Most builders and architects related their perceptions to roof mounted panels. Their reactions to building-integrated SWH systems were more positive.

- Builders stated that use by other builders was not an important attribute of SWH, but they do need to keep up with other builders products and are always looking for ways to differentiate themselves.

- SWH panels are more difficult to integrate and maintain on tile roofs. Unfortunately, tile roofs are the roofing material of choice in many regions where solar water heating can have the best performance.

- First costs and payback period were the most important economic attributes to builders. The money saved through SWH does not appear to be enough to create consumer demand; a combination of buying motives is necessary. Mortgage lenders and energy efficient mortgages were not identified as being influential to the SWH decision making process.

- Incorporating SWH into the construction process was not generally viewed as an issue.

- The need for redundant water heating systems was seen as a negative. Builders felt a conventional water heating system would always be needed to account for extended cloudy periods.

- There was widespread ignorance among builders and architects about SWH incentives, tax breaks and laws in reference to CC&Rs. Most builders reacted favorably to the concept of direct incentive programs.

VI. Recommended Technology Development, Market Development, and Other Courses of Action

- Concentrate on aesthetics and system integration issues rather than incremental increases in SWH performance efficiency. Architects expressed interest in charettes to redesign SWH to address aesthetic and construction issues.

- Work with roofing product manufacturers to develop products and processes that address flashing and roof penetration issues; this is especially important for tile roofs.

- Technical and marketing efforts that reduce perceptions of maintenance and durability issues will reduce builder liability concerns and increase consumer confidence. Ideal warranty requirements should be identified and SWH systems should be designed to meet them. Creating a partnership to guarantee warranties may be an effective tool.

- Develop consumer awareness campaign to place SWH in realm of new home options.

VII. Recommendations for Working Collaboratively with the Home Building Industry

- Conduct design charrettes with architects, builders and installation contractors to design alternative SWH panel concepts.

- Conduct conjoint analysis with builders to determine their willingness to make realistic design, cost and performance tradeoffs for SWH and how SWH can fit into leading builders' energy and resource efficiency practices.

- Develop turn-key installation program featuring certified products and installers.

- Conduct field tests and demonstration programs with most innovative SWH products.

    ⇒ Establish teams between builder, SWH manufacturer, utility company, architect, trade contractor (roofer, plumber), mechanical equipment manufacturer, and Research Center for design development and field trials with SWH specifically suited to residential construction. Builders with SWH experience were very positive; they may be good candidates for demonstrations, case studies, technology transfer and/or outreach efforts. Builders want to hear from other builders.

- Conduct additional qualitative research to identify effective messages, themes, and channels for builders and consumers. One theme to consider may be "Keeping America on Top" since according to architects, we are falling behind in production and use of SWH compared to other countries.

- Create builder demand and awareness through use by opinion leading builders such as EnergyValue Housing Award winning builders.

- Implement consumer demand and awareness campaign through showcase installations with opinion leading builders and marketing campaigns in new home construction media.

APPENDIX A

PHOTOGRAPHS

PHOTOGRAPH 1

A combined solar/photovoltaic system mounted
to a rack standing several feet above the plane of the roof.

PHOTOGRAPH 2

Two rectangular glass and metal panels mounted to a tile roof several feet apart.

PHOTOGRAPH 3

A single glass and metal panel mounted to a tile roof.

NAHB RESEARCH CENTER

400 Prince George's Boulevard • Upper Marlboro, MD 20774-8731 • (301) 249-4000 • FAX (301) 249-030